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BEDOK VIEW SECONDARY SCHOOL

END-OF-YEAR EXAMINATION 2023

CANDIDATE
NAME

REGISTER
NUMBER

CLASS

MATHEMATICS

Secondary 3 Express /

3 Normal Academic (Express Syllabus)

4052/01

29 September 2023

2 hours

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your index number and name on all the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions.

If working is needed for any question it must be shown with the answer.

Omission of essential working will result in loss of marks.

The use of an approved scientific calculator is expected, where appropriate.

If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.

For π , use either your calculator value or 3.142, unless the question requires the answer in terms of π .

The number of marks is given in brackets [] at the end of each question or part question.

The total of the marks for this paper is 80.

Total	
--------------	--

Setter: Ms Sherine Wong

Parent's / Guardian's Signature: 8 8 8 8 8 8 8 8 ..8

This document consists of 17 printed pages.

[Turn over

Mathematical Formulae*Compound Interest*

$$\text{Total amount} = P \left(1 + \frac{r}{100} \right)^n$$

Mensuration

$$\text{Curved surface area of a cone} = \pi r l$$

$$\text{Surface area of a sphere} = 4\pi r^2$$

$$\text{Volume of a cone} = \frac{1}{3} \pi r^2 h$$

$$\text{Volume of a sphere} = \frac{4}{3} \pi r^3$$

$$\text{Area of triangle } ABC = \frac{1}{2} ab \sin C$$

$$\text{Arc length} = r\theta, \text{ where } \theta \text{ is in radians}$$

$$\text{Sector area} = \frac{1}{2} r^2 \theta, \text{ where } \theta \text{ is in radians}$$

Trigonometry

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc \cos A$$

Statistics

$$\text{Mean} = \frac{\sum fx}{\sum f}$$

$$\text{Standard Deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f} \right)^2}$$

3

Answer **all** the questions.

- 1 (a) Evaluate $0.00837940 \div 5601.2$, expressing your answer in standard form.

Answer [1]

- (b) The integers x and y , when rounded to the nearest 100, are 2500 and 3600 respectively. Find the minimum possible value of $y - 2x$.

Answer [2]

- 2 Given that $S = \frac{2a}{3}\sqrt{b^2 - n^2}$, make n the subject of the formula.

Answer [3]

[Turn over]

4

- 3 Write as a single fraction in its simplest form $\frac{3x}{(2x-1)^2} - \frac{2}{2x-1}$.

Answer [2]

- 4 Factorise fully $3bc - 6cd - 4b + 8d$.

Answer [2]

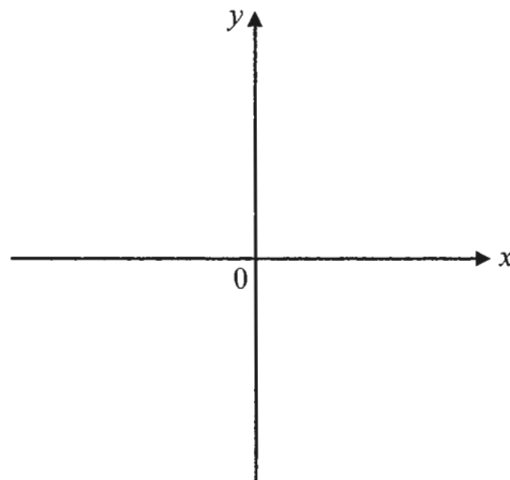
5

- 5 (a) Solve $x^2 + 2x - 6 = 0$ by completing the square.

Answer $x = \dots\dots\dots$ or $\dots\dots\dots$ [3]

- (b) Hence, sketch the graph of the function $y = x^2 + 2x - 6$, indicating clearly the x -intercepts, the y -intercept, and the coordinates of the turning point.

Answer



[2]

6

- 6 A map has a scale of 1 : 8000. The area of a park is $39\,200\text{ m}^2$.
Calculate the area, in square centimetres, of the park on the map.

Answer cm^2 [2]

- 7 Given that $784 = 2^4 \times 7^2$, find the values of prime numbers m and n such that
 $784 \times \frac{m}{n}$ is a perfect cube.

Answer $m = \dots\dots\dots$, $n = \dots\dots\dots$ [2]

7

8 Simplify $\left(\frac{a^{2h+1}\sqrt{a}}{\sqrt{a^{3h}}}\right)^2$.

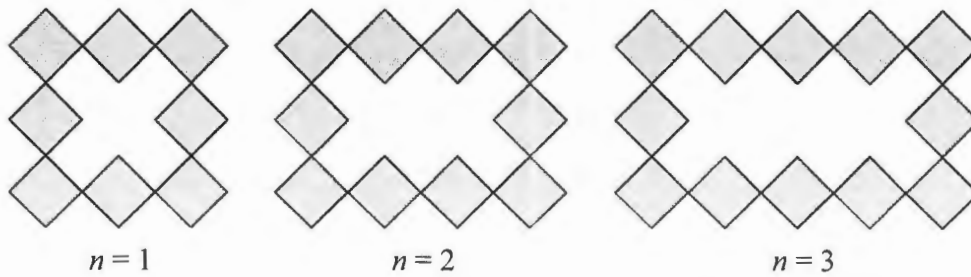
Answer [3]

- 9 The coordinates of points P and Q are given as $(-1, 4)$ and $(2, -6)$ respectively.
Line L meets the line passing through points P and Q at point $R(1, -3)$.
Given that the product of the gradients of the two lines is -1 , find the equation of L .

Answer [4]

[Turn over

- 10 The diagram shows a sequence of blank spaces formed by coloured square tiles of area 1 unit² each.



Let the area and perimeter of the **blank** space in the n th figure be A_n units² and P_n units respectively.

- (a) Find an expression in terms of n for
(i) A_n ,

Answer [1]

- (ii) P_n .

Answer [1]

- (b) Find the perimeter of the blank space if its area is 92 units².

Answer [2]

- 11 Given that $7 \sin x = 3$, find two possible values for angle x , where $0^\circ \leq x \leq 180^\circ$.

Answer $x =$ or [2]

- 12 The frequency table records the number of books read by 50 members in a book club in a particular month.

Number of books read	3	4	5	6
Frequency	20	p	14	q

- (a) Show that $p + q = 16$.

Answer

[1]

- (b) Given that the mean number of books read is 4.4, show that $2p + 3q = 45$.

Answer

[2]

- (c) Hence, find the value of p and of q .

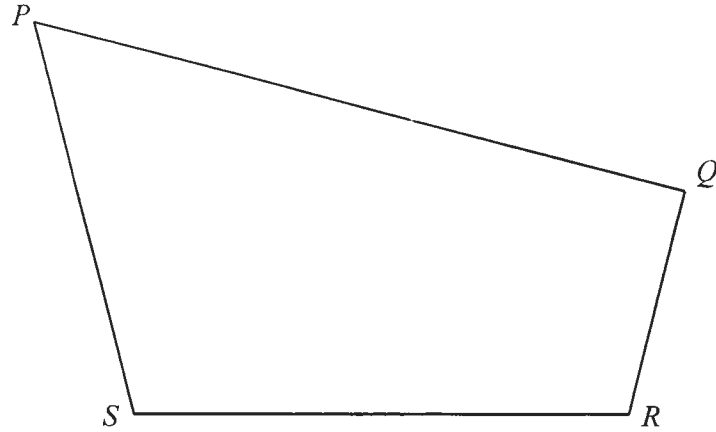
Answer $p = \dots\dots\dots, q = \dots\dots\dots$ [2]

- (d) State the median number of books read.

Answer $\dots\dots\dots$ [1]

10

- 13 The diagram represents a plot of land, $PQRS$, which is to be used for a community club.



- (a) Construct the perpendicular bisector of PQ . [1]
- (b) Construct the bisector of angle QRS . [1]
- (c) A fitness center is to be built in the community club, nearer to Q than P , and nearer to SR than to QR . Shade the region where the fitness center is to be built. [1]
-
- 14 The sum of the squares of three negative consecutive integers is 194.
Find the value of the middle integer.

Answer [3]

11

- 15 Shane bought a skateboard and a bicycle. He paid \$ x for the skateboard and the total price of both items was \$1000. He then sold the skateboard at $\frac{3}{4}$ of its original price and the bicycle for $\frac{300}{x}$ of its original price.

- (a) Express the prices of the skateboard and the bicycle at which Shane sold them for in terms of x .

Answer Skateboard \$

Bicycle \$ [2]

- (b) Given that Shane made a profit of \$175 from selling both items, form an equation in terms of x and show that it reduces to $3x^2 - 5900x + 1200000 = 0$.

Answer

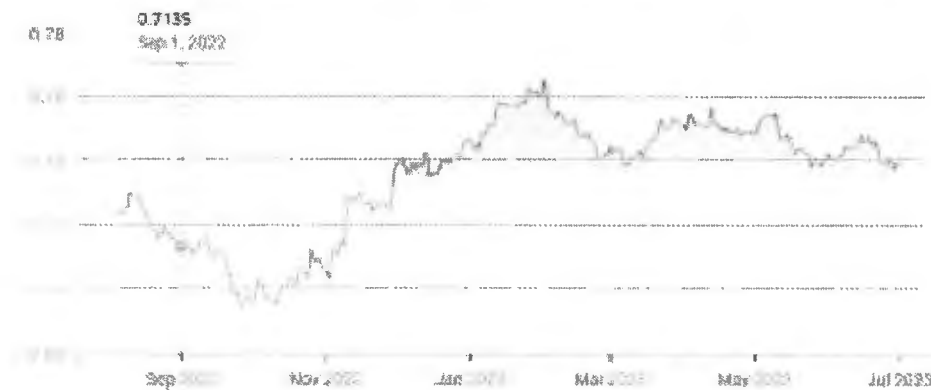
[2]

- (c) Hence find the original price that Shane paid for the bicycle, giving your answer correct to two decimal places.

Answer \$ [3]

[Turn over

- 16 The chart shows the exchange rate of 1 Singapore Dollar (SGD) to United States Dollar (USD) from August 2022 to July 2023.



- (a) Based on the chart, the exchange rate for 1 SGD on 1 September 2022 was 0.7135 USD. Mr Rogers made a funds transfer from his SGD account to USD account amounting to 12000 USD on that day. What was the amount deducted from his SGD account?

Answer SGD [2]

- (b) On 1 June 2023, Mr Rogers decided to transfer 12000 USD from his USD account back to his SGD account. By **estimating** the exchange rate on that day, find his gain or loss in SGD as compared to his previous funds transfer 9 months ago.

Answer Mr Rogers gained / lost (*circle accordingly*) SGD. [2]

- (c) Mrs Rogers thinks that the exchange rate has tripled from October 2022 to March 2023. Explain why this is not true.

Answer

.....

..... [1]

13

- 17 Is it possible for the interior angle of a regular polygon to be 165° ? Justify your answer.

Answer

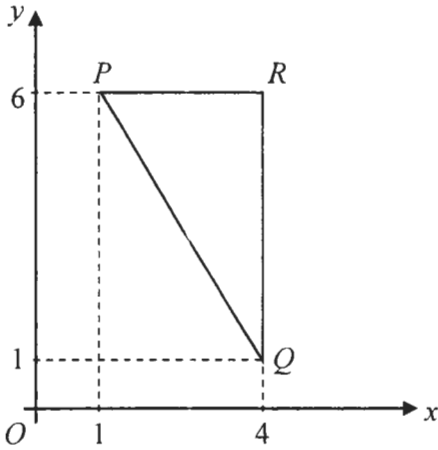
[2]

-
- 18 Given that the ratio of the base area of two similar solids is $169 : 289$, find the ratio of their volumes.

Answer : [2]

[Turn over

19 The diagram shows triangle PQR such that angle PRQ is a right angle.



(a) Find the area of triangle PQR .

Answer units² [1]

(b) Find angle RPQ .

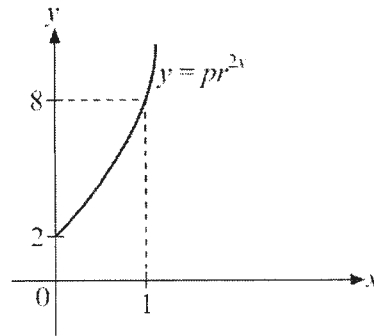
Answer ° [2]

(c) Find the shortest distance from R to PQ .

Answer units [2]

15

- 20 A sketch of the graph of $y = pr^{2x}$, where p and r are positive constants for $x \geq 0$ is shown below.



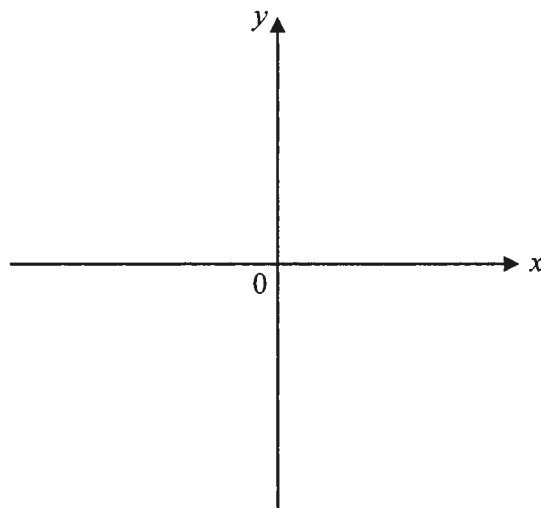
Find the value of p and of r .

Answer $p = \dots\dots\dots$, $r = \dots\dots\dots$ [2]

- 21 On the axes below, sketch and label the graphs of $y = x^3$ and $y = \frac{1}{x^2}$.

Label the intercepts (if any) and the coordinates of the point of intersection (if any).

Answer



[3]

[Turn over

16

- 22 (a) Solve the simultaneous inequalities $6x + 5 \leq 20$ and $5 - 5x < 55$.

Answer [3]

- (b) Represent your solution in part (a) on the number line below.

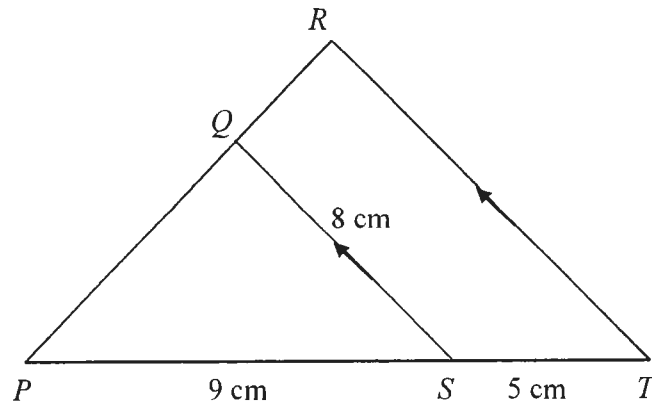
Answer

—————→ x

[1]

17

- 23 In the diagram, $PS = 9$ cm, $ST = 5$ cm, $QS = 8$ cm and SQ is parallel to TR . PQR and PST are straight lines.



- (a) Show that triangles PQS and PRT are similar.

Answer

[2]

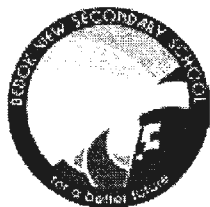
- (b) Find the length of RT .

Answer cm [2]

- (c) Given that the area of triangle PQS is 162 cm², find the area of triangle PRT .

Answer cm² [2]

END OF PAPER



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3

Answer **all** the questions.

- 1 (a) Evaluate $0.00837940 \div 5601.2$, expressing your answer in standard form.

$$\begin{aligned} &0.00837940 \div 5601.2 \\ &= 0.000001496 \\ &= 1.50 \times 10^{-6} \quad \text{[B1]} \end{aligned}$$

[1]

- (b) The integers x and y , when rounded to the nearest 100, are 2500 and 3600 respectively. Find the minimum possible value of $y - 2x$.

$$\begin{aligned} x_{\min} &= 2450 & x_{\max} &= 2549 \\ y_{\min} &= 3550 & y_{\max} &= 3649 \end{aligned}$$

$$\begin{aligned} &\text{Minimum possible value of } y - 2x \\ &= 3550 - 2(2549) \\ &= -1548 \quad \text{[B2]} \end{aligned}$$

[2]

- 2 Given that $S = \frac{2a}{3}\sqrt{b^2 - n^2}$, make n the subject of the formula.

$$\begin{aligned} S &= \frac{2a}{3}\sqrt{b^2 - n^2} \\ \frac{3S}{2a} &= \sqrt{b^2 - n^2} \quad \text{[M1]} \end{aligned}$$

$$\begin{aligned} \left(\frac{3S}{2a}\right)^2 &= b^2 - n^2 \\ n^2 &= b^2 - \left(\frac{3S}{2a}\right)^2 \quad \text{[M1]} \end{aligned}$$

$$n = \pm \sqrt{b^2 - \left(\frac{3S}{2a}\right)^2} \quad \text{[A1] Only with } \pm$$

[3]

[Turn over

4

- 3 Write as a single fraction in its simplest form $\frac{3x}{(2x-1)^2} - \frac{2}{2x-1}$.

$$\frac{3x}{(2x-1)^2} - \frac{2}{2x-1}$$

$$= \frac{3x}{(2x-1)^2} - \frac{2(2x-1)}{(2x-1)^2} \quad [\text{M1}] \text{ Equivalent fraction using common denominator}$$

$$= \frac{3x - 4x + 2}{(2x-1)^2}$$

$$= \frac{2-x}{(2x-1)^2} \quad [\text{A1}]$$

[2]

- 4 Factorise fully $3bc - 6cd - 4b + 8d$.

$$3bc - 6cd - 4b + 8d$$

$$= 3c(b - 2d) - 4(b - 2d) \quad [\text{M1}] \text{ Factorise}$$

$$= (b - 2d)(3c - 4) \quad [\text{A1}]$$

[2]

5

- 5 (a) Solve $x^2 + 2x - 6 = 0$ by completing the square.

$$x^2 + 2x - 6 = 0$$

$$x^2 + 2x + \left(\frac{2}{2}\right)^2 - \left(\frac{2}{2}\right)^2 - 6 = 0 \quad [\text{M1}] \text{ Completing the square}$$

$$(x+1)^2 - 7 = 0$$

$$(x+1)^2 = 7 \quad [\text{M1}]$$

$$x+1 = \pm\sqrt{7}$$

$$x = -1 \pm \sqrt{7}$$

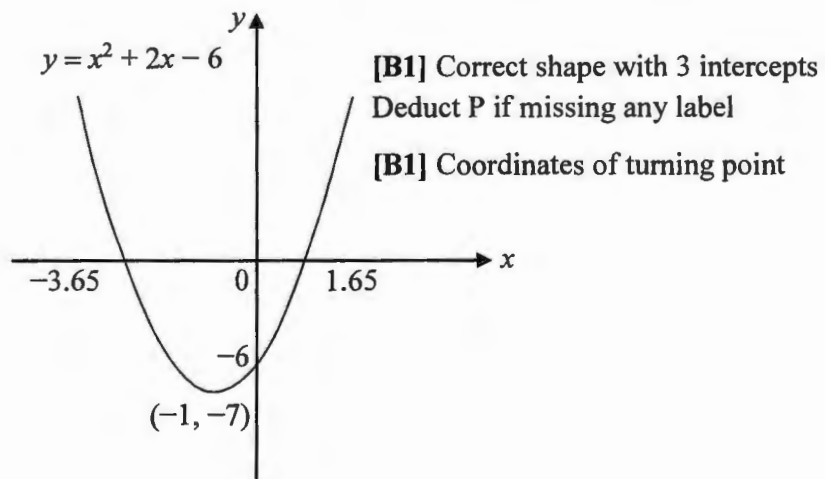
$$x = -3.64575 \text{ or } 1.64575$$

$$x = -3.65 \text{ or } 1.65 \text{ (3 s.f.)} \quad [\text{A1}]$$

[3]

- (b) Hence, sketch the graph of the function $y = x^2 + 2x - 6$, indicating clearly the x -intercepts, the y -intercept, and the coordinates of the turning point.

Answer



y-intercept

$$\text{Sub. } x = 0: y = -6$$

Turning point

$$\text{Minimum value is } -7 \text{ when } x = -1, \text{ ie. } (-1, -7)$$

[2]

[Turn over

6

- 6 A map has a scale of 1 : 8000. The area of a park is 39 200 m². Calculate the area, in square centimetres, of the park on the map.

$$1 : 8000$$

$$1 \text{ cm} : 8000 \text{ cm}$$

$$1 \text{ cm} : 80 \text{ m}$$

$$1 \text{ cm}^2 : 6400 \text{ m}^2 \quad [\text{M1}] \text{ Area scale}$$

Area of the park on the map

$$= \frac{39200}{6400}$$

$$= 6.125 \text{ cm}^2 \quad [\text{A1}] \text{ Exact value only}$$

$$\text{or } 6\frac{1}{8} \text{ cm}^2$$

[2]

- 7 Given that $784 = 2^4 \times 7^2$, find the values of prime numbers m and n such that

$$784 \times \frac{m}{n} \text{ is a perfect cube.}$$

$$784 \times \frac{m}{n}$$

$$= 2^4 \times 7^2 \times \frac{m}{n}$$

To be a perfect cube,

$$m = 7 \quad [\text{B1}]$$

$$n = 2 \quad [\text{B1}]$$

[2]

8 Simplify $\left(\frac{a^{2h+1}\sqrt{a}}{\sqrt{a^{3h}}}\right)^2$.

$$\begin{aligned} & \left(\frac{a^{2h+1}\sqrt{a}}{\sqrt{a^{3h}}}\right)^2 \\ &= \frac{a^{2(2h+1)}(a^{\frac{1}{2}})^2}{a^{\frac{3h}{2}(2)}} \quad \text{[M1] Law 3} \\ &= a^{4h+2+1-3h} \quad \text{[M1] Laws 1 \& 2} \\ &= a^{h+3} \quad \text{[A1]} \end{aligned}$$

[3]

- 9 The coordinates of points P and Q are given as $(-1, 4)$ and $(2, -6)$ respectively.
Line L meets the line passing through points P and Q at point $R(1, -3)$.
Given that the product of the gradients of the two lines is -1 , find the equation of L .

$$\begin{aligned} \text{Gradient of } PQ &= \frac{4-(-6)}{-1-2} \quad \text{[M1]} \\ &= -\frac{10}{3} \end{aligned}$$

$$\begin{aligned} \text{Gradient of line } L &= -1 \div \left(-\frac{10}{3}\right) \quad \text{[M1FT]} \\ &= 0.3 \end{aligned}$$

$$y = 0.3x + c \quad \text{[M1FT]}$$

$$-3 = 0.3(1) + c$$

$$c = -3.3$$

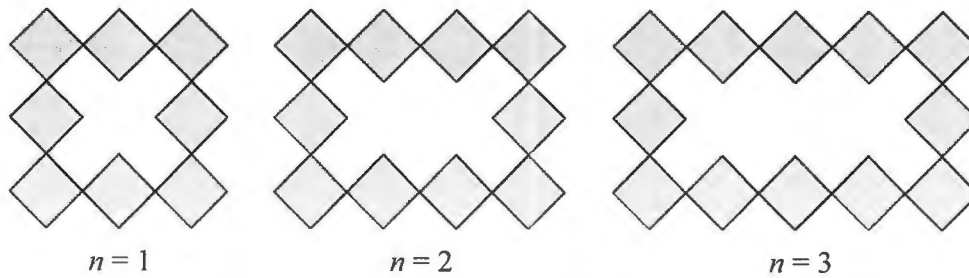
$$\text{Equation of } L \text{ is } y = 0.3x - 3.3 \quad \text{[A1]}$$

$$\text{Accept } y = \frac{3}{10}x - \frac{33}{10} \text{ or } 10y = 3x - 33$$

[4]

[Turn over]

- 10 The diagram shows a sequence of blank spaces formed by coloured square tiles of area 1 unit² each.



Let the area and perimeter of the **blank** space in the n th figure be A_n units² and P_n units respectively.

- (a) Find an expression in terms of n for

(i) A_n ,

$$A_n = 5, 8, 11, \dots$$

$$A_n = 3n + 2 \quad [\text{B1}]$$

[1]

(ii) P_n .

$$P_n = 12, 16, 20, \dots$$

$$P_n = 4n + 8 \quad [\text{B1}]$$

[1]

- (b) Find the perimeter of the blank space if its area is 92 units².
Hence, express P_n in terms of A_n .

$$3n + 2 = 92 \quad [\text{M1FT}] \text{ from (a)(i)}$$

$$3n = 90$$

$$n = 30$$

$$P_n = 4(30) + 8$$

$$P_n = 128 \quad [\text{A1}]$$

[2]

- 11 Given that $7 \sin x = 3$, find two possible values for angle x , where $0^\circ \leq x \leq 180^\circ$.

$$x = \sin^{-1} \frac{3}{7} \quad [\text{M1}]$$

$$= 25.376 \text{ or } 154.623$$

$$= 25.4^\circ \text{ or } 154.6^\circ \text{ (1 d.p.)} \quad [\text{A1}] \text{ For both values}$$

[2]

- 12 The frequency table records the number of books read by 50 members in a book club in a particular month.

Number of books read	3	4	5	6
Frequency	20	p	14	q

- (a) Show that $p + q = 16$.

Answer

$$20 + p + 14 + q = 50 \quad [\text{B1}]$$

$$p + q = 16 \quad (\text{Shown})$$

For Question 10

Deduct P once if "shown" is not written.

[1]

- (b) Given that the mean number of books read is 4.4, show that $2p + 3q = 45$.

Answer

$$\frac{3(20) + 4p + 5(14) + 6q}{50} = 4.4 \quad [\text{M1}]$$

$$4p + 6q + 130 = 220$$

$$4p + 6q = 90$$

$$2p + 3q = 45 \quad (\text{Shown}) \quad [\text{A1}]$$

[2]

- (c) Hence, find the value of p and of q .

$$\text{From (a), } p = 16 - q \quad \text{-----(1)}$$

$$\text{Sub. (1) in (b): } 2(16 - q) + 3q = 45$$

$$32 - 2q + 3q = 45$$

$$q = 13 \quad [\text{B1}]$$

$$\text{From (1), } p = 16 - 13$$

$$p = 3 \quad [\text{B1}]$$

[2]

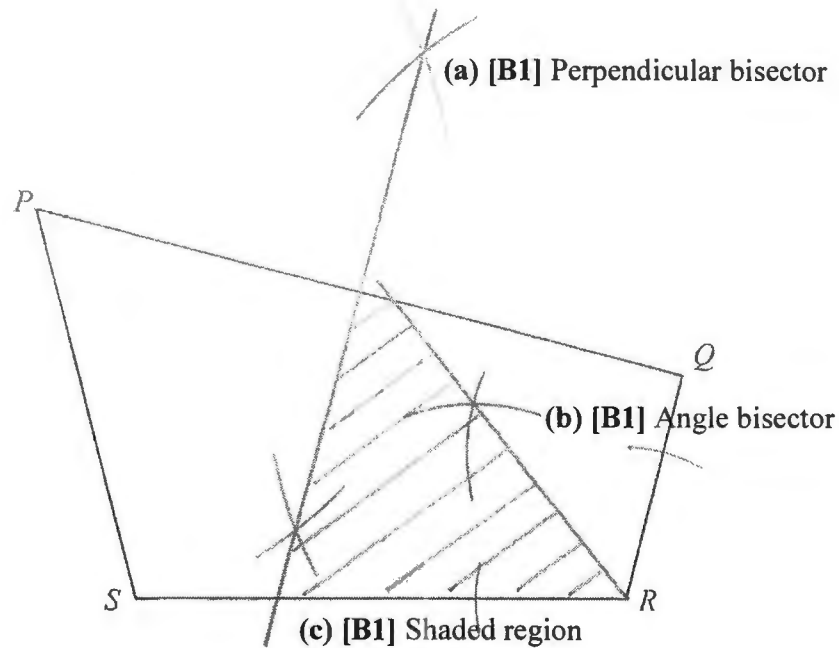
- (d) State the median number of books read.

$$\text{Median} = 5 \quad [\text{B1}]$$

[1]

[Turn over

- 13 The diagram represents a plot of land, $PQRS$, which is to be used for a community club.



- (a) Construct the perpendicular bisector of PQ . [1]
- (b) Construct the bisector of angle QRS . [1]
- (c) A fitness center is to be built in the community club, nearer to Q than P , and nearer to SR than to QR . Shade the region where the fitness center is to be built. [1]
-
- 14 The sum of the squares of three negative consecutive integers is 194.
Find the value of the middle integer.

Let x be the middle integer.

Then

$$(x-1)^2 + x^2 + (x+1)^2 = 194 \quad \text{[M1] Form equation based on definition of } x$$

$$x^2 - 2x + 1 + x^2 + x^2 + 2x + 1 = 194 \quad \text{[M1FT] Expand}$$

$$3x^2 = 192$$

$$x^2 = 64$$

$$x = -8 \quad (\text{since } x \text{ is negative})$$

The middle integer is -8 . [A1]

[3]

11

- 15 Shane bought a skateboard and a bicycle. He paid \$ x for the skateboard and the total price of both items was \$1000. He then sold the skateboard at $\frac{3}{4}$ of its original price and the bicycle for $\frac{300}{x}$ of its original price.

- (a) Express the prices of the skateboard and the bicycle at which Shane sold them for in terms of x .

$$\text{Skateboard} = \$ \frac{3}{4}x \quad [\text{B1}]$$

$$\text{Bicycle} = \$ \frac{300}{x}(1000 - x) \quad [\text{B1}]$$

[2]

- (b) Given that Shane made a profit of \$175 from selling both items, form an equation in terms of x and show that it reduces to $3x^2 - 5900x + 1200000 = 0$.

Answer

$$\frac{3}{4}x + \frac{300}{x}(1000 - x) - 1000 = 175 \quad [\text{M1}] \text{ Form equation for profit}$$

$$\frac{3}{4}x + \frac{300000}{x} - 300 - 1000 = 175$$

$$\frac{3}{4}x + \frac{300000}{x} - 1475 = 0$$

$$3x^2 - 5900x + 1200000 = 0 \quad (\text{Shown}) \quad [\text{A1}] \text{ Deduct P if "shown" is not written}$$

[2]

- (c) Hence find the original price that Shane paid for the bicycle, giving your answer correct to two decimal places.

$$x = \frac{-(-5900) \pm \sqrt{(-5900)^2 - 4(3)(1200000)}}{2(3)} \quad [\text{M1}]$$

$$= \frac{5900 \pm \sqrt{20410000}}{6}$$

$$= 230.376 \text{ or } 1736.290 \text{ (reject since } > 1000) \quad [\text{M1}] \text{ No M1 if 1736.290 is not rejected}$$

Original price that Shane paid for the bicycle

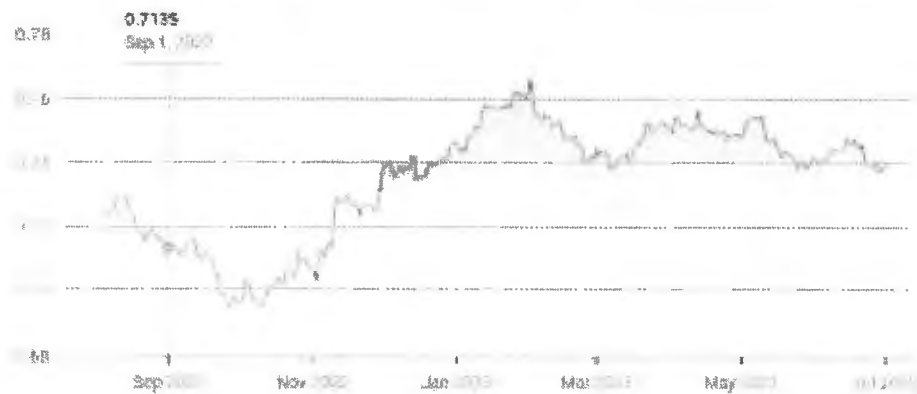
$$= 1000 - 230.376$$

$$= \$ 769.62 \text{ (2 d.p.)} \quad [\text{A1}]$$

[3]

[Turn over

- 16 The chart shows the exchange rate of 1 Singapore Dollar (SGD) to United States Dollar (USD) from August 2022 to July 2023.



- (a) Based on the chart, the exchange rate for 1 SGD on 1 September 2022 was 0.7135 USD. Mr Rogers made a funds transfer from his SGD account to USD account amounting to 12000 USD on that day. What was the amount deducted from his SGD account?

$$1 \text{ SGD} : 0.7135 \text{ USD}$$

$$1 \text{ USD} : \frac{1}{0.7135} \text{ SGD}$$

$$12000 \text{ USD} : \frac{12000}{0.7135} \text{ SGD} \quad [\text{M1}]$$

Amount deducted was 16818.50 SGD (2 d.p.). [A1]

[2]

- (b) On 1 June 2023, Mr Rogers decided to transfer 12000 USD from his USD account back to his SGD account. By **estimating** the exchange rate on that day, find his gain or loss in SGD as compared to his previous funds transfer 9 months ago.

Exchange rate for 1 SGD on 1 June 2023 was approx. 0.74/0.741/0.742 USD.

$$1 \text{ USD} : \frac{1}{0.74} \text{ SGD}$$

$$12000 \text{ USD} : \frac{12000}{0.74} = 16216.22 \text{ SGD} \quad [\text{M1}] \text{ Accept } 16194.33 \text{ or } 16172.51$$

Mr Rogers lost 602.28 SGD. [A1] Accept 624.17 or 645.99

[2]

- (c) Mrs Rogers thinks that the exchange rate has tripled from October 2022 to March 2023. Explain why this is not true.

Answer

If the exchange rate has tripled, it would be $3(0.7) = 2.1$ instead of approximately 0.74. / Although the height is 3 times more, the vertical axis does not start at 0.

[B1] For any reasonable explanation related to height or 3x value of 0.7.

[1]

13

- 17 Is it possible for the interior angle of a regular polygon to be 165° ? Justify your answer.

Answer

If the interior angle is 165° , then

the exterior angle is 15° [M1]

the number of sides of the regular polygon is $\frac{360}{15} = 24$ [A1]

Accept finding n through sum of interior angles.

Yes this is possible.

[2]

- 18 Given that the ratio of the base area of two similar solids is $169 : 289$, find the ratio of their volumes.

$$\left(\frac{l_1}{l_2}\right)^2 = \frac{169}{289} \quad [\text{M1}]$$

$$\frac{l_1}{l_2} = \frac{13}{17}$$

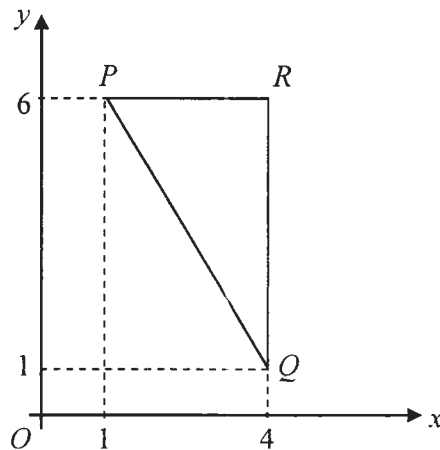
$$\left(\frac{l_1}{l_2}\right)^3 = \frac{2197}{4913}$$

Ratio of their volumes is $2197 : 4913$ [A1]

[2]

[Turn over]

- 19 The diagram shows triangle PQR such that angle PRQ is a right angle.



- (a) Find the area of triangle PQR .

Area of triangle PQR

$$= \frac{1}{2}(3)(5)$$

$$= 7.5 \text{ units}^2 \quad [\text{B1}]$$

[1]

- (b) Find angle RPQ .

$$\tan \angle RPQ = \frac{5}{3} \quad [\text{M1}]$$

$$\angle RPQ = \tan^{-1} \frac{5}{3}$$

$$= 59.036$$

$$= 59.0^\circ \text{ (1 d.p.)} \quad [\text{A1}]$$

[2]

- (c) Find the shortest distance from R to PQ .

$$\frac{\text{Shortest distance from } R \text{ to } PQ}{3} = \sin 59.036^\circ \quad [\text{M1}]$$

$$\text{Shortest distance from } R \text{ to } PQ = 3 \sin 59.036^\circ$$

$$= 2.57247$$

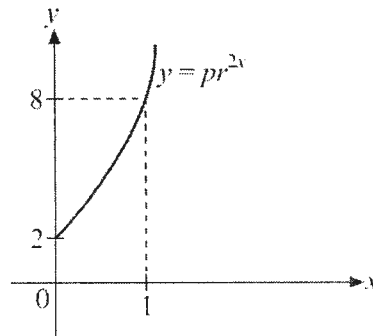
$$= 2.57 \text{ units (3 s.f.)} \quad [\text{A1}]$$

Accept finding shortest distance by area of triangle & PQ ($\sqrt{34}$) as base.

[2]

15

- 20 A sketch of the graph of $y = pr^{2x}$, where p and r are positive constants for $x \geq 0$ is shown below.



Find the value of p and of r .

Sub. (0, 2):

$$2 = pr^{2(0)}$$

$$p = 2 \quad \text{[B1]}$$

Sub. (1, 8):

$$8 = 2r^{2(1)}$$

$$r^2 = 4$$

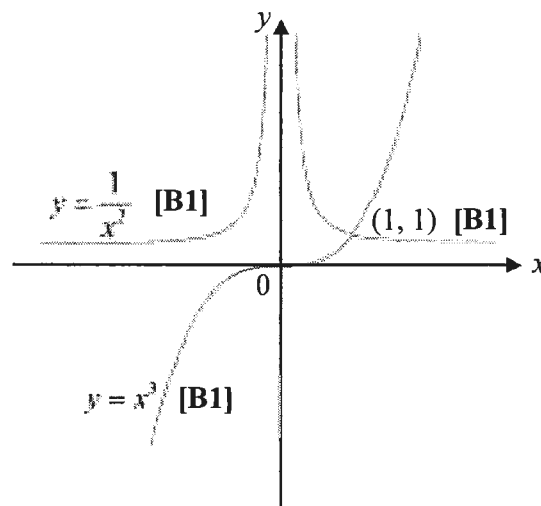
$$r = 2 \text{ (since } r > 0) \quad \text{[B1]}$$

[2]

- 21 On the axes below, sketch and label the graphs of $y = x^3$ and $y = \frac{1}{x^2}$.

Label the intercepts (if any) and the coordinates of the point of intersection (if any).

Answer



[3]

[Turn over

- 22 (a) Solve the simultaneous inequalities $6x + 5 \leq 20$ and $5 - 5x < 55$.

$$\left. \begin{array}{l} 6x + 5 \leq 20 \\ 6x \leq 15 \\ x \leq 2.5 \end{array} \right\} \quad [\text{M1}]$$

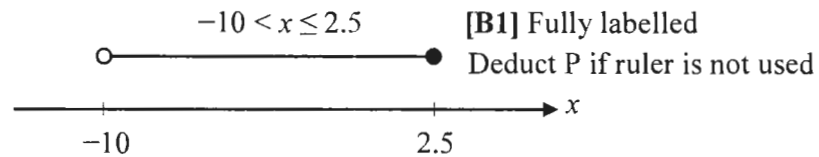
$$\left. \begin{array}{l} 5 - 5x < 55 \\ -5x < 50 \\ x > -10 \end{array} \right\} \quad [\text{M1}]$$

$$-10 < x \leq 2.5 \quad [\text{A1}]$$

[3]

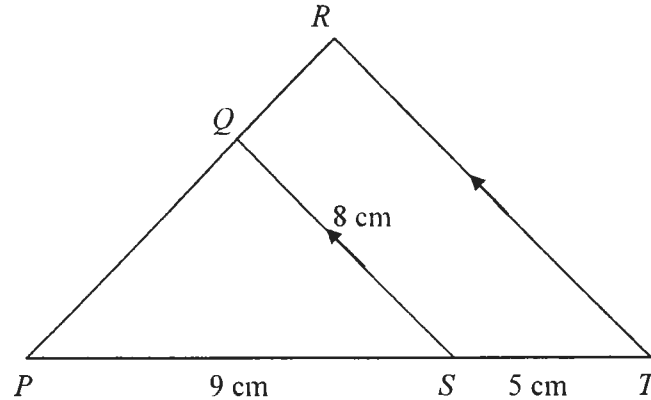
- (b) Represent your solution in part (a) on the number line below.

Answer



[1]

- 23 In the diagram, $PS = 9$ cm, $ST = 5$ cm, $QS = 8$ cm and SQ is parallel to TR .
 PQR and PST are straight lines.



- (a) Show that triangles PQS and PRT are similar.

$$\left. \begin{array}{l} \angle QPS = \angle RPT \text{ (common angle)} \\ \angle PQS = \angle PRT \text{ (corresponding angles, } QS \parallel RT) \\ \angle QSP = \angle RTP \text{ (corresponding angles, } QS \parallel RT) \end{array} \right\} \begin{array}{l} \text{[M1] Any 2 of these reasons} \\ \text{Deduct P if reasons not stated} \end{array}$$

By AA Similarity Test, $\triangle PQS$ and $\triangle PRT$ are similar triangles. [A1]

No A1 if not stated

[2]

- (b) Find the length of RT .

$$\frac{RT}{QS} = \frac{PT}{PS} \text{ (corr. sides of similar } \Delta\text{s)} \quad \text{[M1]}$$

$$\frac{RT}{8} = \frac{14}{9}$$

$$RT = \frac{14}{9} \times 8$$

$$RT = 12\frac{4}{9} \text{ cm or } 12.4 \text{ cm (3 s.f.)} \quad \text{[A1]}$$

[2]

- (c) Given that the area of triangle PQS is 162 cm^2 , find the area of triangle PRT .

$$\frac{\text{area of } \triangle PRT}{\text{area of } \triangle PQS} = \left(\frac{14}{9}\right)^2 \quad \text{[M1]}$$

$$\frac{\text{area of } \triangle PRT}{162} = \frac{196}{81}$$

$$\begin{aligned} \text{area of } \triangle PRT &= \frac{196}{81} \times 162 \\ &= 392 \text{ cm}^2 \end{aligned} \quad \text{[A1]}$$

[2]

END OF PAPER



BEDOK VIEW SECONDARY SCHOOL

END-OF-YEAR EXAMINATION 2023

CANDIDATE
NAME

REGISTER
NUMBER

CLASS

MATHEMATICS

**Secondary 3 Express/ 3 Normal Academic
(Express Syllabus)**

Paper 2

4052/02

3 October 2023

2 hours

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your index number and name on all the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions.

If working is needed for any question it must be shown with the answer.

Omission of essential working will result in loss of marks.

The use of an approved scientific calculator is expected, where appropriate.

If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.

For π , use either your calculator value or 3.142, unless the question requires the answer in terms of π .

The number of marks is given in brackets [] at the end of each question or part question.
The total of the marks for this paper is 80.

Total	
--------------	--

Setter: Mr Ho

Parent's / Guardian's Signature: 8 8 8 8 8 8 8 8 ..8

This document consists of **19** printed pages.

[Turn over

2

Mathematical Formulae*Compound Interest*

$$\text{Total amount} = P \left(1 + \frac{r}{100} \right)^n$$

Mensuration

$$\text{Curved surface area of a cone} = \pi r l$$

$$\text{Surface area of a sphere} = 4\pi r^2$$

$$\text{Volume of a cone} = \frac{1}{3} \pi r^2 h$$

$$\text{Volume of a sphere} = \frac{4}{3} \pi r^3$$

$$\text{Area of triangle } ABC = \frac{1}{2} ab \sin C$$

$$\text{Arc length} = r\theta, \text{ where } \theta \text{ is in radians}$$

$$\text{Sector area} = \frac{1}{2} r^2 \theta, \text{ where } \theta \text{ is in radians}$$

Trigonometry

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc \cos A$$

Statistics

$$\text{Mean} = \frac{\sum fx}{\sum f}$$

$$\text{Standard Deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f} \right)^2}$$

3

Answer **all** the questions.

- 1 (a) v is inversely proportional to the square of x and when $v = 4$, $x = 3$.
Find the value of x when $v = \frac{1}{4}$.

Answer $x = \dots\dots\dots$ [2]

- (b) s is directly proportional to the square root of r and it is known that $s = 4$ for a particular value of r . Find the value of s when the value of r is increased to 400%.

Answer $s = \dots\dots\dots$ [3]

[Turn Over

4

- 2 John opens a savings account with *ABC* bank and deposits a certain amount of money into the account. The sum of money grows to \$46 634.58 after one year and \$47 474.00 after 2 years at a certain interest rate, which is compounded annually.

(a) Find the interest rate per annum given by the bank.

Answer% [2]

- (b) Find the amount of money, correct to the nearest \$10, John deposited at the start.

Answer \$..... [2]

5

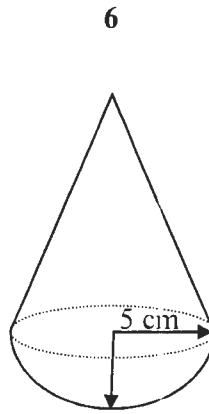
- (c) The bank decides to offer John the option to open a new savings account which is compounded monthly. Using the same interest rate and principal calculated in part (a) and part (b), should John switch to the new savings account? Justify your answer with relevant working.

Answer:

John should/ should not (cancel accordingly) switch to the new savings account because _____

[3]

3



The diagram shows a metal ornament formed by joining the plane face of a solid hemisphere of radius 5 cm to the base of a solid cone of radius 5 cm.

- (a) Find the volume of the hemisphere.

Answercm³ [2]

- (b) Given that the total volume of the ornament is 413 cm³, find the height of the cone.

Answercm [2]

7

- (c) The metal ornament is formed by melting a solid metal cylinder of height 24 cm and diameter 20 cm. Find the total number of complete metal ornaments that can be made.

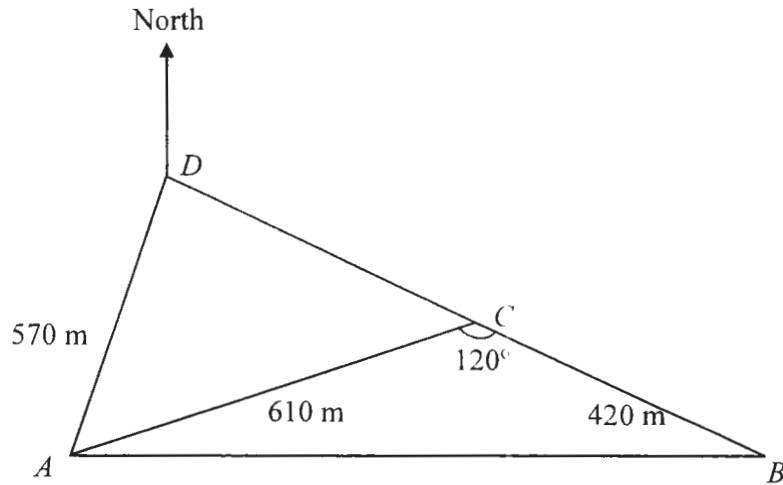
Answer [3]

- (d) When transporting the solid metal cylinders, the solid cylinders are packed into a box with height 40 cm, length 100 cm and width 65 cm. Find the maximum number of solid cylinders that can fit into the box.

Answer [4]

8

- 4 The following figure shows a park $ABCD$. $AD = 570$ m, $AC = 610$ m and $BC = 420$ m. B is east of A and BCD is a straight line. Angle $ACB = 120^\circ$.



- (a) Calculate the length of AB .

Answerm [3]

- (b) Calculate angle ADC .

Answer° [2]

9

(c) Calculate the bearing of D from B .

Answer ° [3]

(d) A drone is spotted 70 m directly above C .
Find the greatest angle of elevation of the drone from a point along AB .

Answer ° [3]

(a) Find the value of p .

[Turn Over

- 5 The variables x and y are connected by the equation $y = \frac{x^3}{5} - x + 2$.

Some corresponding values of x and y are given in the table below.

x	-4	-3	-2	-1	0	1	2	3
y	-6.8	p	2.4	2.8	2	1.2	1.6	4.4

Answer [1]

- (b) On the grid on page 12, draw the graph of $y = \frac{x^3}{5} - x + 2$ for $-4 \leq x \leq 3$. [3]

- (c) By drawing a suitable tangent on the same grid, find the gradient of the curve when $x = 2$.

Answer [2]

- (d) (i) On the same grid, draw the graph of $2y = -x + 2$. [1]

- (ii) Using your graph, state the x -coordinate of the intersection point between the curve and the line.

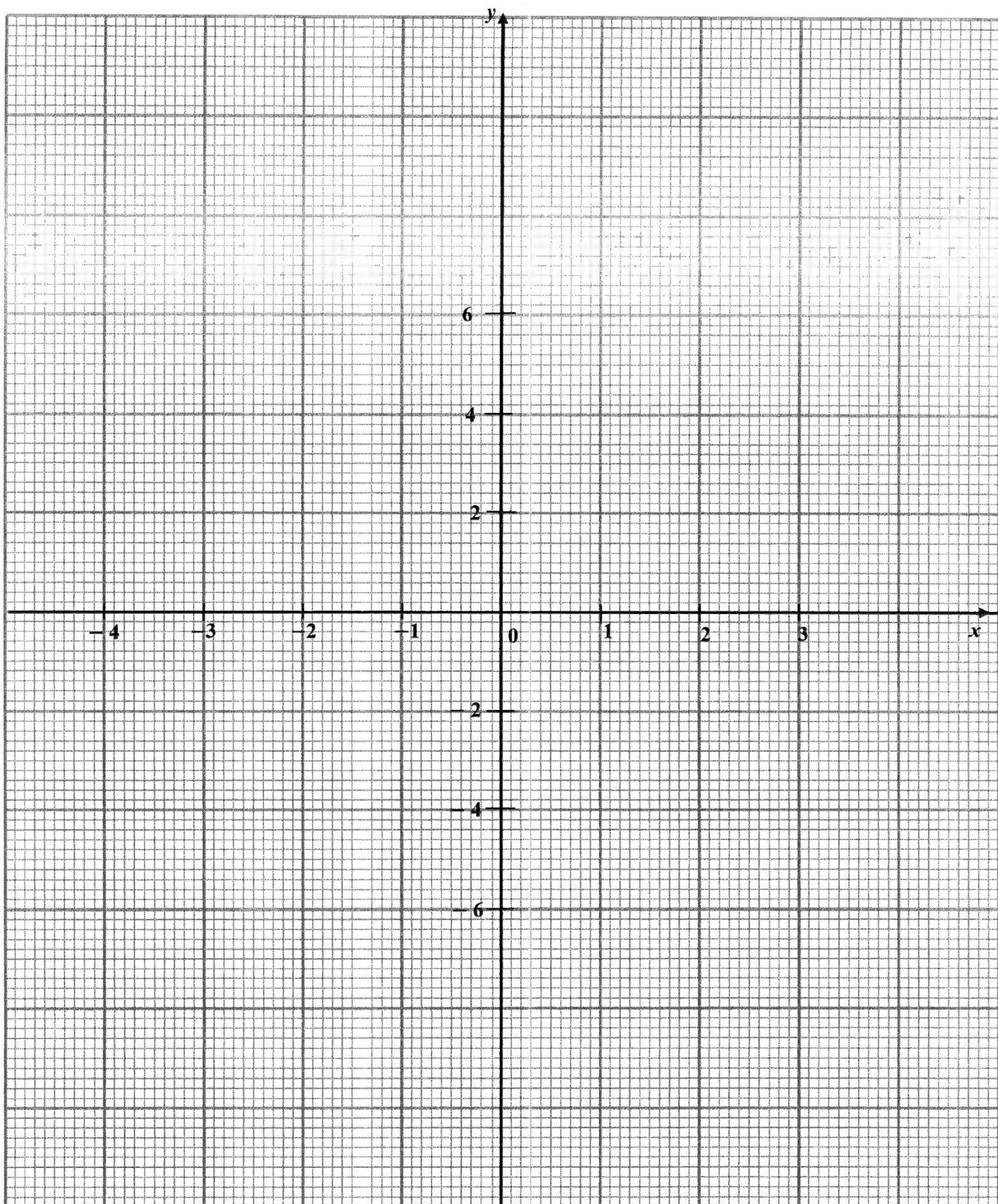
Answer $x = \dots\dots\dots$ [1]

- (iii) The roots of the equation $2x^3 + ax^2 + bx + c = 0$ is given by the x -value of the intersection point in part (d)(ii). Find the values of a , of b and of c .

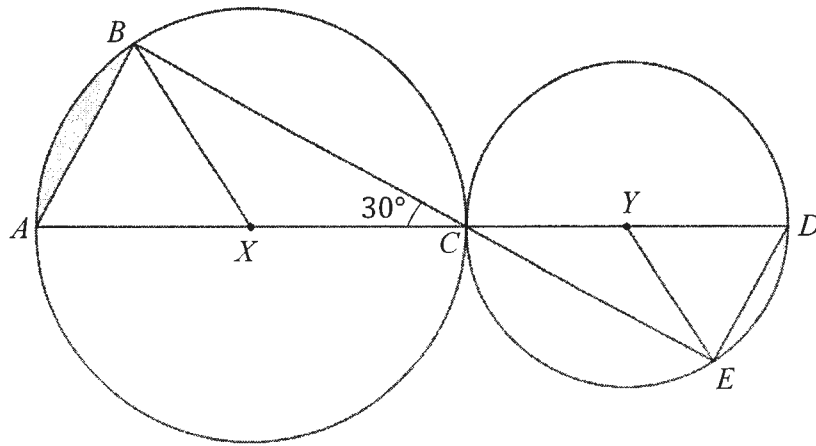
Answer $a = \dots\dots\dots$, $b = \dots\dots\dots$, $c = \dots\dots\dots$ [3]

[Turn Over

12



6



The diagram shows two circles that touch at C . A , B and C are points on the bigger circle with centre X . C , D and E are points on the smaller circle with centre Y . BCE and $AXCYD$ are straight lines.

- (a) Given that angle $BCX = 30^\circ$, find

(i) angle CXB ,

Answer $^\circ$ [1]

(ii) angle XAB .

Answer $^\circ$ [1]

- (b) What type of triangle is triangle XAB ?

Answer [1]

- (c) The radius of the larger circle is 9 cm and the radius of the smaller circle is 6 cm.

(i) Find the area of the minor sector XAB , leaving your answer in terms of π .

Answer cm^2 [2]

[Turn Over

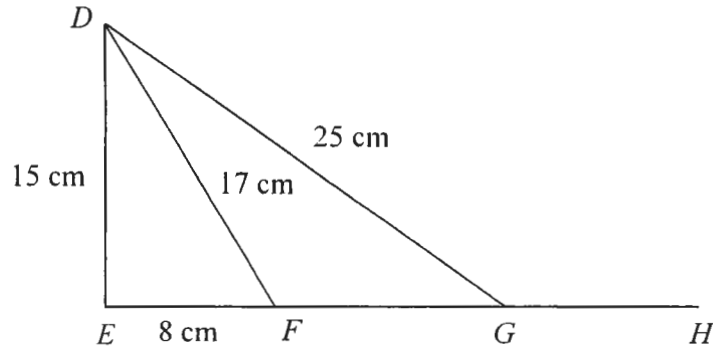
14

- (ii) Calculate the percentage of the shaded areas to the total area of the two circles.

Answer % [6]

15

- 7 In the diagram below, $DE = 15\text{ cm}$, $DF = 17\text{ cm}$, $DG = 25\text{ cm}$, $EF = 8\text{ cm}$ and $EFGH$ is a straight line.



- (a) Show that triangle DEF is a right-angled triangle.

Answer

[2]

- (b) Find angle DGF .

Answer° [2]

[Turn Over

16

- (c) Find the length of FG .

Answercm [2]

- (d) If angle $DFG = \theta$, find, without the use of a calculator,

(i) $\cos \theta$,

Answer [1]

(ii) $\sin(90^\circ - \angle DFE)$.

Answer [2]

17

8 (a) Solve the equation $\frac{4}{x+3} - \frac{3}{x^2+3x} = \frac{7}{x}$.

Answer $x = \dots\dots\dots$ [3]

(b) Express $\frac{4x-1}{x^2-9} - \frac{2}{x-3}$ as a single fraction.

Answer $\dots\dots\dots$ [3]

- 9 A food delivery company, Company A, hires delivery riders in order to deliver food from food establishments to the customers' location. The delivery riders are paid for each delivery they made based on the following algorithm.

Amount paid per delivery = base fee + distance fee
--

The base fee is \$2.50 and the distance fee is the distance between the food establishment to the customer's location. The table below shows the distance fee allocation.

Distance travelled (x) (in metres)	Distance fee
$0 < x \leq 400$	\$0.10
$400 < x \leq 1000$	\$0.20
$1000 < x \leq 1500$	\$0.32
$1500 < x \leq 2000$	\$0.45
$x > 2000$	\$0.80

- (a) Amy, a delivery rider, travels 1.6 km from the restaurant to the customer. How much would she be paid for the delivery?

Answer \$ [2]

- (b) John, a delivery rider, gets \$3.30 for a delivery. What is a possible distance (in km) he could have travelled?

Answerm [2]

19

- (c) The delivery rider has the option to accept or reject any delivery order that comes to him. The acceptance rate is the percentage of orders accepted by the delivery rider with respect to the total number of orders received.

A delivery rider will receive a bonus of \$30 if they accepted 30 or more orders in a week and their acceptance rate is 95% or more.

David has accepted 35 orders and rejected 3 orders this week. What is the minimum number of orders he must continue to accept to qualify for the bonus? Assume he does not reject any other order.

Answerorders [3]

- (d) Peter says that it is better to make a few short trips rather than one long trip. Do you agree with Peter? Give a reason for your answer.

Answer

[2]

END OF PAPER

Bedok View Secondary School

Mathematics Department

Marking Scheme

Year	2023	Level & Stream	Sec 3E
Type of Exam	EYE exam	Subject	Math P2

No.		Working	Remarks
1	(a)	$v = \frac{k}{x^2}$ Sub $v = 4, x = 3,$ $4 = \frac{k}{(3)^2}$ $k = 36 \quad [\text{M1}] \text{ for calculating } k$ Sub $v = \frac{1}{4},$ $\frac{1}{4} = \frac{36}{x^2}$ $x^2 = 144$ $x = \pm 12 \quad [\text{A1}]$	If no $\pm$, do not award A1.
	(b)	$s = k\sqrt{r}$ When $s = 4,$ $s_1 = k\sqrt{4r} \quad [\text{M1}] \text{ for correct proportion formula}$ $s_1 = 2k\sqrt{r}$ $s_1 = 2s \quad [\text{M1 FT}] \text{ for correct equation}$ $\therefore s = 2(4) = 8 \quad [\text{A1}]$	

[Total : 5m]

Bedok View Secondary School

Mathematics Department

Marking Scheme

No.		Working	Remarks
2	(a)	let x be the interest rate per annum. $x = \frac{47474.00 - 46634.58}{46634.58} \times 100\% \text{ [M1] correct equation}$ $= 1.79999$ $= 1.80\% \text{ (3 sf) [A1]}$	
	(b)	$46634.58 = P \left(1 + \frac{1.79999}{100} \right)^1 \text{ [M1 FT] correct values}$ $P = \frac{46634.58}{1.0179}$ $P = \$45814.50$ $P = \$48510 \text{ (Nearest \$10) [A1]}$	
	(c)	For the new account, $A = 45814.50 \left(1 + \frac{1.79}{100} \right)^{12} \text{ [M1 FT] correct } r \text{ and } n \text{ values.}$ $A = \$46641.34 \text{ [M1 FT] correct evaluation}$ Since $\\$46641.34 > \\46634.58, John should switch accounts. [A1]	

[Total : 7m]

Bedok View Secondary School
Mathematics Department

Marking Scheme

No.		Working	Remarks												
3	(a)	Volume of hemisphere $= \frac{2}{3} \pi r^3$ $= \frac{2}{3} \pi (5)^3 \quad [\text{M1}] \text{ correct value substituted in}$ $= 261.799$ $= 262 \text{ (3 sf) cm}^3 \quad [\text{A1}]$													
	(b)	Let h be the height of the cone. $413 = \frac{1}{3} \pi r^2 h + \frac{2}{3} \pi (5)^3$ $151.201 = \frac{1}{3} \pi (5)^2 h \quad [\text{M1 FT}] \text{ correct values substituted in}$ $h = \frac{(151.201)(3)}{25\pi}$ $h = 5.7754$ $h = 5.78 \text{ cm (3sf) [A1]}$													
	(c)	Volume of metal cylinder $= \pi (10)^2 (24) \quad [\text{M1}] \text{ volume of cylinder}$ $= 2400\pi$ Number of metal ornaments $= \frac{2400\pi}{413} \quad [\text{M1 FT}] \text{ correct equation}$ $= 18.256$ $\therefore$ 18 ornaments [A1]													
	(d)	<table><tr><th>Height</th><th>Length</th><th>Width</th></tr><tr><td>$= \frac{40}{20}$</td><td>$= \frac{100}{24}$</td><td>$= \frac{65}{20}$</td></tr><tr><td>$= 2$</td><td>$= 4.16$</td><td>$= 3.25$</td></tr><tr><td></td><td>$= 4$</td><td>$= 3$</td></tr></table> Total cyclinders [M1, M1, M1] M1 for each correct calculation.	Height	Length	Width	$= \frac{40}{20}$	$= \frac{100}{24}$	$= \frac{65}{20}$	$= 2$	$= 4.16$	$= 3.25$		$= 4$	$= 3$	
Height	Length	Width													
$= \frac{40}{20}$	$= \frac{100}{24}$	$= \frac{65}{20}$													
$= 2$	$= 4.16$	$= 3.25$													
	$= 4$	$= 3$													

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Mathematics Department

Marking Scheme

		$= 2 \times 4 \times 3$ $= 24 \text{ cylinders [A1]}$	
--	--	--	--

[Total : 11 m]

Bedok View Secondary School

Mathematics Department

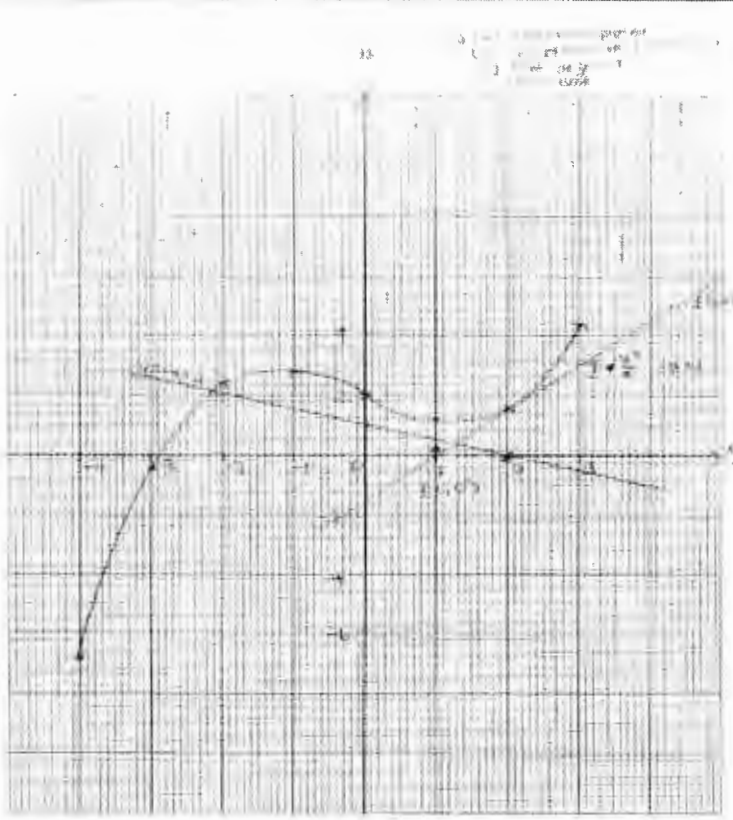
Marking Scheme

No.		Working	Remarks
4	(a)	$(AB)^2 = (610)^2 + (420)^2 - 2(610)(420)\cos(120^\circ)$ [M2] cosine rule $(AB)^2 = 804700$ $AB = 897.05$ $AB = 897 \text{ m (3sf)}$ [A1]	
	(b)	$\angle ACD = 180^\circ - 120^\circ = 60^\circ$ (adjacent angles on a straight line) $\frac{\sin(60^\circ)}{570} = \frac{\sin(\angle ADC)}{610}$ [M1] sine rule $\sin(\angle ADC) = \frac{\sin(60^\circ)}{670} \times 610$ $\sin(\angle ADC) = 0.926799$ $\angle ADC = 67.941^\circ$ $\angle ADC = 67.9^\circ$ (1dp) [A1]	
	(c)	$\frac{\sin(120^\circ)}{897.05} = \frac{\sin(\angle CBA)}{610}$ $\sin(\angle CBA) = \frac{\sin(120^\circ)}{897.05} \times 610$ $\sin(\angle CBA) = 0.58890$ $\angle CBA = 36.079^\circ$ [M1 FT] correct angle value $\angle CBA = 36.1^\circ$ Bearing of D from B $= 270 + 36.079$ [M1 FT] sum of angles for bearings $= 306.1^\circ$ (1 dp) [A1]	
	(d)	let shortest distance from C to AB be x . $\sin(36.079^\circ) = \frac{x}{420}$ [M1 FT] calculation of shortest dist $x = 247.33$ Greatest angle of elevation $= \tan^{-1}\left(\frac{70}{247.33}\right)$ [M1 FT] calculation of angle of elevation $= 15.8^\circ$ (1dp) [A1]	

[Total : 11m]

Bedok View Secondary School
Mathematics Department

Marking Scheme

No.		Working	Remarks
5	(a)	$p = -0.4$ [B1]	
	(b)	 [B2] all points plotted correctly (1- 2 points plotted wrongly → B1, 3 points of more plotted wrongly → 0 marks) [B1] points are joined in a smooth curve	No label minus P
	(c)	[B1] Tangent drawn. Gradient $= \frac{6-0}{5-1}$ $= 1.5 \text{ (Accept values between 1.2 to 1.8) [B1]}$	

Bedok View Secondary School

Mathematics Department

Marking Scheme

	(d)	(i)	[B1] – Line drawn and labelled	No label minus P
		(ii)	$x = -2.15$ (Accept ± 0.1) [B1]	
		(iii)	$\frac{x^3}{5} - x + 2 = -\frac{1}{2}x + 1$ [M1] equating both equations. $2x^3 - 10x + 20 = -5x + 10$ $2x^3 - 5x + 10 = 0$ [M1] correct manipulation $a = 0, b = -5, c = 10$. [A1] for all 3 correct values	

[Total : 11m]

Bedok View Secondary School

Mathematics Department

Marking Scheme

No.		Working	Remarks
6	(ai)	$\angle CXB = 180^\circ - 30^\circ - 30^\circ$ (Sum of angle in an isos triangle) $= 120^\circ$ [B1]	Deduct P for no reason/ wrong reason
	(aia)	$\angle XAB = \frac{180^\circ - 60^\circ}{2}$ (Sum of angles in a straight line) $= 60^\circ$ [B1]	Deduct P for no reason/ wrong reason
	(b)	Equilateral triangle. [B1]	
	(c)(i)	Area of minor sector XAB $= \frac{60^\circ}{360^\circ} \times \pi (9)^2$ [M1] formula to find area of sector $= 13\frac{1}{2}\pi \text{ cm}^2$ [A1]	
	(c)(ii)	Area of triangle XAB $= \frac{1}{2}(9)(9)\sin(60^\circ)$ [M1] area of triangle XAB $= 35.074$ Area of minor sector $YDE = \frac{60^\circ}{360^\circ} \times \pi (6)^2$ [M1] area of minor sector YDE $= 6\pi$ Area of triangle YDE $= \frac{1}{2}(6)(6)\sin(60^\circ)$ $= 15.588$ [M1] area of triangle YDE Percentage of shaded area $= \frac{\left(13\frac{1}{2}\pi - 35.074\right) + (6\pi - 15.588)}{\pi(9)^2 + \pi(6)^2} \times 100\%$ $= \frac{10.599}{367.56} \times 100\%$ $= 2.8835$ $= 2.88\%$ (3 sf) [A1]	[M1 FT, M1 FT] calculation of each shaded area

[Total : 11m]

Bedok View Secondary School
Mathematics Department

Marking Scheme

No.	Working		Remarks
7	(a)	$ \begin{aligned} &15^2 + 8^2 \\ &= 225 + 64 \\ &= 289 \\ &= 17^2 \end{aligned} $ [M1] use of Pythagoras theorem <u>By the converse of pythagoras theorem</u>, triangle DEF is a right-angle triangle. [A1]	No A1 if underlined statement is not written.
	(b)	$ \begin{aligned} \sin(\angle DGF) &= \frac{15}{25} \quad [\text{M1}] \text{ correct sin ratio} \\ \angle DGF &= \sin^{-1}\left(\frac{15}{25}\right) \\ &= 36.86989^\circ \\ &= 36.9^\circ \text{ (1 d.p.) } [\text{A1}] \end{aligned} $	
	(c)	$ \begin{aligned} EG^2 + 15^2 &= 25^2 \quad [\text{M1}] \text{ Pythagoras theorem} \\ EG &= 20 \\ FG &= 20 - 8 \\ &= 12 \text{ cm } [\text{A1}] \end{aligned} $	
	(d) (i)	$ \begin{aligned} \cos(\angle DFG) \\ &= -\cos(\angle DFE) \\ &= -\frac{8}{17} \quad [\text{B1}] \end{aligned} $	
	(ii)	$ \begin{aligned} &\sin(90^\circ - \angle DFE) \\ &= \sin(\angle EDF) \quad [\text{M1}] \text{ complementary property} \\ &= \frac{8}{17} \quad [\text{A1}] \end{aligned} $	

[Total : 9m]

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Marking Scheme

No.		Working	Remarks
8	(a)	$\frac{4}{x+3} - \frac{3}{x^2+3x} = \frac{7}{x}$ $\frac{4x}{x^2+3x} - \frac{3}{x^2+3x} = \frac{7(x+3)}{x^2+3x} \quad [\text{M1}] \text{ common denominator}$ $4x-3 = 7x+21 \quad [\text{M1}] \text{ correct equation}$ $-3x = 24$ $x = -8 \quad [\text{A1}]$	Accept other mathematically sound methods
	(b)	$\frac{4x-1}{x^2-9} - \frac{2}{x-3}$ $= \frac{4x-1}{(x-3)(x+3)} - \frac{2}{x-3} \quad [\text{M1}] \text{ application of algebraic identity}$ $= \frac{4x-1}{(x-3)(x+3)} - \frac{2(x+3)}{(x-3)(x+3)}$ $= \frac{4x-1-2x-6}{(x-3)(x+3)} \quad [\text{M1}] \text{ combine into single fraction}$ $= \frac{2x-7}{(x-3)(x+3)} \quad [\text{A1}]$	

[Total : 6m]

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Marking Scheme

No.	Working		Remarks
9	(a)	Amount paid $= 2.50 + 0.45$ [M1] correct values $= \$2.95$ [A1]	
	(b)	Distance fee $= 3.30 - 2.50$ [M1] correct values $= \$0.80$ Accept any distance more than 2000 m. [A1]	
	(c)	Let x be the number of orders the David must accept. $\frac{3}{38+x} \times 100 = 5$ [M1] correct equation $\frac{3}{38+x} = 0.05$ $3 = 1.9 + 0.05x$ [M1 FT] correct manipulation $0.05x = 1.1$ $x = 22$ [A1] David must accept at least 22 orders.	
	(d)	Yes I agree with Peter [B1] because every additional trip earns at least \$2.50 more which is higher than any distance fee. [B1]	Accept any other logical answer.

[Total: 9m]

